

WHAT IS CLAIMED IS:

1. A lithographic projection apparatus comprising:
a support structure constructed to support a patterning structure, said patterning structure adapted to pattern a beam of radiation according to a desired pattern;
a substrate holder constructed to hold a substrate;
a projection system constructed and arranged to project the patterned beam onto a target portion of the substrate;
a downstream radical source, connected to a gas supply, configured to provide a beam of radicals directed onto a surface to be cleaned.
2. A lithographic projection apparatus according to claim 1, wherein said beam of radicals contains substantially no ionized particles.
3. A lithographic projection apparatus according to claim 1, wherein said gas supply supplies at least one of oxygen, hydrogen, and fluorine.
4. A lithographic projection apparatus according to claim 3, wherein said downstream radial source provides a beam of at least one of oxygen radicals, hydrogen radicals, and fluorine radicals.
5. A lithographic projection apparatus according to claim 1, wherein said surface to be cleaned is on one of the patterning structure, a sensor, a lens, a deflector, and a reflector for reflecting one of the beam of radiation and the patterned beam.
6. A lithographic projection apparatus according to claim 1, wherein the position of the downstream radical source is fixed.
7. A lithographic projection apparatus according to claim 6, further comprising a structure to direct said beam of radicals onto a surface to be cleaned, said structure comprising a device that moves the component containing said surface such that the beam of radicals is incident on said surface.

8. A lithographic projection apparatus according to claim 1, wherein the downstream radical source comprises at least one of an RF coil, a pair of DC discharge electrodes, a microwave cavity, and an RF cavity that generates a region of plasma within the flow of gas from the gas supply, the radicals being created in said plasma region.

9. A lithographic projection apparatus according to claim 1, wherein the downstream radical source comprises a high temperature element located within the flow of the gas from the gas supply, the temperature of the high temperature element being sufficient to cause thermal dissociation to create the radicals.

10. A lithographic projection apparatus according to claim 1, further comprising:
an evacuated chamber that contains the patterning structure, the substrate, and the projection system,

wherein the downstream radical source comprises a tube, the beam of radicals are discharged from an end of said tube, and said end of the tube is located in the evacuated chamber.

11. A lithographic projection apparatus according to claim 10, wherein the region of the downstream radical source in which the radicals are formed is located outside of the evacuated chamber.

12. A lithographic projection apparatus according to claim 1, wherein the apparatus comprises at least two downstream radical sources and corresponding beams of radicals for cleaning said surface.

13. A lithographic projection apparatus according to claim 1, wherein said surface to be cleaned comprises a surface of an optical element.

14. A device manufacturing method comprising:
providing a beam of radiation;
patterning the beam of radiation;
projecting the patterned beam of radiation onto a target portion of a layer of radiation-sensitive material;

providing a flow of gas in a downstream radical source to produce a beam of radicals;
and
directing said beam of radicals onto a surface to be cleaned.

15. A lithographic projection apparatus comprising:
a radiation source that provides a beam of radiation;
a support structure constructed to support a patterning structure, said patterning structure adapted to pattern the beam of radiation according to a desired pattern;
a substrate holder constructed to hold a substrate;
a projection system constructed and arranged to project the patterned beam onto a target portion of the substrate;
a radical source connected to a gas supply and configured to provide a localized beam of radicals; and
a structure to direct said beam of radicals onto a surface to be cleaned,
wherein said radical source is disposed away from said radiation source such that operating conditions of said radical source do not adversely affect said beam of radiation.

16. A lithographic projection apparatus according to claim 15, wherein said radical source comprises:
a tube connected to the gas supply at one end, and comprising an orifice at an opposite end; and
a plasma generator to generate a plasma region,
wherein gas from the gas supply flows through the tube and through the plasma region such that neutral and ionized particles are created, and
the beam of radicals exits the tube at the orifice onto the surface to be cleaned.

17. A lithographic projection apparatus according to claim 16, wherein walls of the tube neutralize the ionized particles.

18. A lithographic projection apparatus according to claim 16, wherein a Faraday grid neutralizes the ionized particles.

19. A lithographic apparatus according to claim 18, wherein the Faraday grid is disposed at the orifice of the tube.

20. A lithographic apparatus according to claim 15, wherein said surface to be cleaned comprises a surface of an optical element.